

# Minimally Invasive Surgical Treatment of Esophageal Achalasia

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## ABSTRACT

**Background and Objectives:** A minimally invasive approach is considered the treatment of choice for esophageal achalasia. We report the evolution of our experience from thoracoscopic Heller myotomy (THM) to laparoscopic Heller myotomy (LHM). Our objective is to define the efficacy and safety of these 2 approaches.

**Methods:** Between March 1993 and December 2001, 36 patients underwent minimally invasive surgery for achalasia. Sixteen patients underwent THM without an antireflux procedure, and 20 patients underwent LHM with partial anterior fundoplication (n=13) or closure of the angle of His (n=7).

**Results:** Mean operative time and mean hospital stay were significantly shorter for LHM compared with that of THM (148.3±38.7 vs 222±46.1 min, respectively;  $P=0.0001$ ) and (2.06±0.65 days vs 5.06±0.85 days, respectively;  $P=0.0001$ ). Six of 16 patients (37.5%) in the THM group experienced persistent or recurrent dysphagia compared with 1 of 20 patients (5%) in the LHM group ( $P=0.01$ ). Heartburn developed in 5 patients (31.2%) after THM and in 1 patient (5%) after LHM ( $P=0.06$ ). Regurgitation developed in 4 patients (25%) after THM and in 2 patients (10%) after LHM ( $P=0.2$ ). Lower esophageal sphincter (LES) basal pressure decreased significantly from 30.1±5.07 to 15.3±2.1 after THM and from 31.8±6.2 to 10.4±1.7 after LHM ( $P=0.0001$ ). Mean esophageal diameter was significantly reduced after LHM compared with that after THM (from 53.9±5.9 mm to 27.2±3.3 mm vs 50.8±7.6 mm to 37.2±6.9 mm respectively;  $P=0.0001$ ).

**Conclusion:** In our experience, LHM is associated with better short-term results and is superior to THM in relieving

dysphagia. LHM with partial anterior fundoplication should be considered the treatment of choice for achalasia.

**Key Words:** Achalasia, Heller myotomy, Laparoscopy, Thoracoscopy.

## INTRODUCTION

Achalasia is the most common of the primary motor disorders of the esophagus. The aim of treating patients with achalasia is to relieve the functional obstruction at the lower end of the esophagus, allowing normal esophageal emptying. Extramucosal Heller esophagomyotomy, first described by Heller,<sup>1</sup> can be performed without risk and with accuracy by using minimally invasive techniques<sup>2,3</sup> in the treatment of esophageal achalasia. Thoracoscopic and laparoscopic approaches have fewer complications than the traditional open approaches<sup>2,4</sup> and provide good to excellent relief of dysphagia in 82% to 94% of patients.<sup>2,4</sup> Thoracoscopic Heller myotomy is the first minimally invasive cardiomyotomy used successfully;<sup>2,3</sup> however, it has been largely replaced by the laparoscopic approach,<sup>4,5</sup> which remains as effective as the open technique in relief of dysphagia.<sup>5</sup>

The purpose of this study was to evaluate the results of our experience in treating achalasia and to compare patients' characteristics, operative results, and postoperative outcome with both procedures.

## MATERIALS AND METHODS

Between March 1993 and December 2001, 36 consecutive patients underwent endoscopic Heller myotomy performed by the first author. The diagnosis of achalasia was established based on symptoms, barium esophagogram, upper endoscopy, and esophageal manometry in the majority of patients. Sixteen patients (THM group) underwent a thoracoscopic Heller myotomy. Twenty patients (LHM group) underwent a laparoscopic Heller myotomy, with a Dor fundoplication (13 patients) or with recreation of the angle of His (7 patients).

The mean age of the patients was 38.6 years (range 10 to

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79) in the THM group (8 men and 8 women) and 41.2 years (range 14 to 77) in the LHM group (8 men and 12 women).

The clinical features of the patients are shown in **Tables 1 and 2**. No significant differences existed in length of history and severity of symptoms in both groups.

The mean esophageal diameter was  $50.8 \pm 7.6$  mm in the THM group and  $53.9 \pm 5.9$  mm in the LHM group ( $P=0.1$ ) (**Table 1**).

Stationary esophageal manometry showed a mean lower esophageal sphincter (LES) basal pressure of  $30.1 \pm 5.1$  mm Hg and  $31.8 \pm 6.2$  mm Hg, respectively, in 2 group ( $P=0.3$ ). Mean LES residual pressure in response to wet swallows was  $19.5 \pm 5.3$  mm Hg and  $17.2 \pm 4.6$  mm Hg, respectively ( $P=0.1$ ) (**Table 1**). Esophageal peristalsis was absent in all patients. Three patients (15%), both in the LHM group, had undergone previous abdominal surgery.

### Surgical Technique

The operative technique of the thoracoscopic and laparoscopic approach have previously described by us and others.<sup>5,6,8,11</sup>

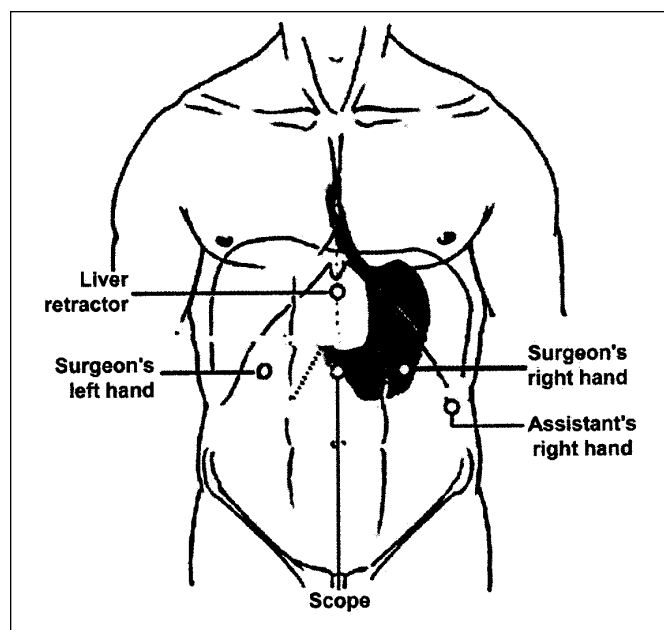
The thoracoscopic approach is carried out through 4 trocars placed on the left chest wall introducing a 30° thoracoscope after the lung is collapsed. To perform the myotomy, we have found it very helpful to use 10-mm curved Metzenbaum scissors. The myotomy is begun at a

point midway between the inferior pulmonary vein and the diaphragmatic hiatus and is carried down approximately 1 cm onto the stomach: the completeness of the myotomy is reached when the gastroesophageal junction lumen becomes patent to the endoscopy. An antireflux procedure is not performed. A chest tube is left in place and usually removed on the second or third postoperative day.

In the laparoscopic approach, access to the abdomen is obtained by the placement of 5 trocars (**Figure 1**). After incision of the phrenoesophageal membrane, the dissection is limited only to the anterior aspect of the esophagus and the superior part of the diaphragmatic crura. The anterior vagus nerve is identified and preserved. The short gastric vessels are not routinely divided and the esophagus is not encircled so that the anatomical attachments of the cardia can be preserved. The esophagomyotomy is carried 6 cm above the esophagogastric junction and extended caudally for 2 cm below the cardia on the gastric wall. The myotomy is performed by stretching and tearing the circular muscle fibers with 2 laparoscopic graspers directed in opposite directions. Once the submucosal plane is reached, the muscular layer is separated bluntly from the submucosa and the stretching myotomy is easily extended proximally and distally. All surgical maneuvers were controlled with the esophagoscope to assess the completeness of the myotomy and ensure mucosal integrity. Once the myotomy was complete, the muscle edges were separated bluntly from the underlying

**Table 1.**  
Preoperative Patient's Characteristics

Patients	THM	LHM	P
Number	16	20	
Age (years)	38.6 (range 10-79)	41.2 (range 14-77)	
Sex	8 M - 8 F	8 M - 12 F	
Stage			
I (<4 cm)	2	1	
II (4-6 cm)	10	12	
III (>6 cm)	4	7	
Previous abdominal surgery	0	3	
Mean LES basal pressure (mm Hg)	$30.1 \pm 5.1$	$31.8 \pm 6.2$	0.3
Mean LES residual pressure (mm Hg)	$19.5 \pm 5.3$	$17.2 \pm 4.6$	0.1
Mean esophageal diameter (mm)	$50.8 \pm 7.6$	$53.9 \pm 5.9$	0.1
Follow-up (months)	36.2 (12-94)	19.2 (4-55)	



**Figure 1.** Trocars setup for laparoscopic Heller myotomy and fundoplication.

**Table 2.**  
Frequency of Preoperative Symptoms

Symptoms	THM		LHM	
	n	%	n	%
Dysphagia	15	93.7%	19	95.0%
Regurgitation	11	68.7%	13	65%
Heartburn	4	25.0%	4	23.5%
Chest pain	5	31.0%	4	20%
Aspiration	2	12.5%	2	11.7%
Weight loss	6	37.5%	5	29.4%

ing mucosa from approximately 50% of the esophageal circumference. A partial anterior fundoplication has not been performed routinely. The anterior wall of the gastric fundus is sutured first to the left, then to the right muscular edges of the myotomy with 3 interrupted stitches for each side. The proximal suture of the right side also includes the superior part of the right crus. In those patients with an esophageal preoperative diameter  $\geq 6$  cm, we only reconstruct the angle of His with 2 or 3 interrupted stitches between the gastric fundus and the left wall of the esophagus. This technique has been

adopted to avoid distal esophageal obstruction.

### Follow-up

The follow-up of patients consisted of clinical, radiographic, and whenever possible, pH-monitoring and manometric evaluation. All patients were evaluated at 1, 6, and 12 months after surgery and then yearly with a 4-point scale according to postoperative symptom frequency (1=occasional, 2=monthly, 3=weekly, 4=daily). Surgical outcomes were based on esophageal diameter at barium swallow, and LES basal and residual pressures at stationary esophageal manometry. Mean follow-up was 36.2 months (range: 12-94 months) for the THM group and 19.2 months (range: 4-55 months) for the LHM group.

### Statistical Analysis

The SPSS statistical package was used to generate a frequency distribution for demographic variables. The independent-samples *t* test was used for comparison of means and the Fisher exact test for comparison of patient subgroups for categorical variables. Results are expressed as mean $\pm$ SD and median. Differences were considered significant at  $P<0.05$ .

## RESULTS

Operative results are shown in **Table 3**. No mortalities were observed in the 2 groups. Mean operative time was 222 minutes (range: 120 to 288 min) in the THM group and 148.3 minutes (range: 60 to 192 min) in the LHM group ( $P=0.0001$ ). Blood loss was negligible in both procedures (mean $<80$  mL).

Three intraoperative esophageal perforations occurred, 2 during THM (12.5%) and 1 during LHM (5%). The first 2 occurred in the mediastinum and were sutured after conversion to a small video-assisted thoracotomy, without postoperative consequences. The laparoscopic perforation occurred at the gastroesophageal junction and was identified by intraoperative endoscopy. It was repaired laparoscopically adding an anterior partial fundoplication to protect the mucosal suture, and the postoperative course was uneventful. The average length of the myotomy was 6.8 cm (range 5 to 7.6 cm) in the THM group and 8.1 cm (range 7 to 10 cm) in the LHM group ( $P=NS$ ). An esophagogram with Gastrografin was performed on the second postoperative day in all patients. No esophageal leaks or obstruction was seen in any of these patients.

**Table 3.**  
Operative Results

Patients	THM	LHM	P
Mean operative time (min)	222 (120-288)	148.3 (60-192)	0.0001
Perforation rate	2 (12.5%)	1 (5.9%)	NS
Conversion rate	2 (12.5%)	0	NS
Morbidity	0	0	
Mortality	0	0	
Mean hospital stay (days)	5.06±0.85	2.06±0.65	0.0001

Mean postoperative length of stay was significantly longer after THM (5.06±0.85 days) than after LHM (2.06±0.65 days) ( $P=0.0001$ ). This was due to the chest tube that was left in place in the first group for 3 days.

Long-term clinical follow-up was available on 100% of patients and was obtained by telephone questionnaire. Recurrent dysphagia was reported by 6 of 16 patients (37.5%) in the THM group. In 4 of these patients, dysphagia was related to the incompleteness of the gastric myotomy shown on the esophagogram; for this reason, a subsequent LHM was performed to extend the myotomy distally onto the stomach. All these patients had excellent or good relief of dysphagia, but 2 other patients underwent pneumatic dilatation with good relief of dysphagia. In the LHM group, only 1 patient (5%) reported occasional dysphagia for 6 months, which eventually resolved spontaneously ( $P=0.01$ ). Postoperative heartburn occurred in 5 of the 6 aforementioned patients with dysphagia (31.2%) in the THM group and in 1 patient (5%) in the LHM group ( $P=0.06$ ). Twelve of 16 patients (75%) in the THM group did not complain of postoperative regurgitation, whereas 4 patients (25%) had episodes of regurgitation on a weekly (2 patients) or daily (2 patients) basis. These patients have been treated with acid-suppression therapy with good control of symptoms. Two patients in the LHM group (10%) reported occasional episodes of regurgitation that did not require therapy ( $P=0.2$ ) (Table 4).

Excellent or good results were reported by 95.2% of the patients who underwent LHM. Those were different from the 62.5% excellent to good results reported in the THM group.

Barium swallow examination showed a significant decrease in mean esophageal diameter after either treatment [from 50.8±7.6 mm to 37.2±6.9 mm in THM group ( $P=0.0001$ ) and from 53.9±5.9 mm to 27.2±3.3 mm ( $P=0.0001$ ) in the LHM group]. However, patients who underwent LHM had a more significant decrease in esophageal diameter compared with patients treated with THM ( $P=0.001$ ) (Table 5).

**Table 4.**  
Clinical Results

Symptoms	THM		LHM		P
	n	%	n	%	
Dysphagia	6*	37.5	1	5	0.01
Heartburn	5	31.2	1	5	0.06
Regurgitation	4	25.0	2	10	0.2

\*4 cases of incomplete myotomy → LHM.

**Table 5.**  
Radiological Results: Esophageal Diameter

	THM	LHM	P
Mean preoperative diameter (cm)	50.8±7.6	53.9±5.9	0.1
Mean postoperative diameter (cm)	37.2±6.9	27.2±3.3	0.0001

Postoperative stationary esophageal manometry and 24-h pH monitoring was performed in 12 patients in each group. A significant reduction in LES basal pressure was evident in both groups [from 30.1±5.7 mm Hg to 15.3±2.1 mm Hg in the THM group ( $P=0.0001$ ), and from 31.8±6.2 mm Hg to 10.4±1.7 mm Hg in the LHM group ( $P=0.0001$ ). The reduction in LES basal pressure was significantly greater in those patients who underwent LHM than in those treated with THM ( $P<0.0001$ ). Manometric results are reported in **Table 6**. Abnormal esophageal acid exposure was objectively documented in 7 patients (58.3%) in the THM group, but only 5 of these were symptomatic for heartburn. In the LHM group, pH monitoring showed an abnormal esophageal acid exposure in 3 patients (15%), but only 1 patient was symptomatic. These patients underwent a Heller myotomy with reconstruction of angle of His.

## DISCUSSION

The present study compares short- and long-term surgical results of our initial experience with 16 patients who underwent thoracoscopic Heller myotomy and 20 patients who underwent laparoscopic Heller myotomy. Only a few other studies<sup>7-11</sup> have compared the results of these 2 procedures in the treatment of achalasia. Although no randomized, controlled trials have compared surgical outcomes after thoracoscopic versus laparoscopic Heller myotomy, a review of the literature shows that the laparoscopic approach offers superior results in patients with achalasia.<sup>5,9-18</sup> Patti et al<sup>9</sup> successfully treated 35 patients by using the thoracoscopic approach until 1994, but subsequently they switched to the laparoscopic approach with Heller myotomy for the next 133 patients. This decision was supported by the higher incidence of recurrent dysphagia (27% compared with 11%) and by the observa-

tion of an increased incidence of abnormal esophageal acid exposure by 24-hour pH monitoring.

In a recent study, Stewart et al<sup>10</sup> showed that laparoscopic myotomy is superior to thoracoscopic myotomy regarding postoperative functional results. In the THM group, the incidence of dysphagia and heartburn was 69% and 33%, respectively, significantly higher compared with the 10% and 11% rate observed after LHM.

In the present series, although good control of preoperative symptoms was obtained after the thoracoscopic approach, we believe that laparoscopic myotomy offers a series of advantages that allow obtaining decreased morbidity and superior operative and functional outcomes. First, working on the distal esophagus from the abdominal cavity, the direction of the instruments is maintained tangentially and parallel to the axis of the lower esophagus. This was essential in our experience for performing the myotomy with great simplicity and to prevent mucosal injury.

In our study, we directly compared the incidence of mucosal injury in both surgical approaches. Perforation of the esophageal mucosa occurred in 2 patients (12.5%) in the THM group, whereas it occurred only in 1 patient (5%) who underwent LHM ( $P=NS$ ). In this patient, we repaired the perforation laparoscopically adding an anterior partial fundoplication to protect the mucosal suture. For this, during the laparoscopic approach, we recommend achieving the completeness of myotomy without extreme apprehension of injury to the mucosa in particular at levels of the gastroesophageal junction. In fact, even in this circumstance, the laparoscopic repair of a mucosal lesion is easy to perform, and the anterior partial fundoplication can be added with a maximal guarantee of good functional outcomes.

**Table 6.**  
Manometric Results

	THM	LHM	<i>P</i>
Mean LES basal pressure (mm Hg)			
Preoperative	30.1±5.1	31.8±6.2	
Postoperative	15.3±2.1	10.4±1.7	0.0001
LES residual pressure (mm Hg)			
Preoperative	19.5±5.3	17.2±4.6	
Postoperative	7.3±1.3	2.9±1.0	0.0001

Regarding long-term results, several studies reported that the laparoscopic technique is associated with a lower rate of dysphagia, heartburn, and regurgitation compared with the thoracoscopic technique. In a retrospective study, Stewart et al<sup>10</sup> reported relief of dysphagia in 90% of patients treated with LHM and in 31% of those treated with THM. In addition, the authors found a lower incidence of heartburn (11%) and regurgitation (6%) after LHM compared with that observed after THM (33% and 14%, respectively). Patti et al<sup>9</sup> reported the occurrence of persistent dysphagia in 27% of patients who underwent THM and in 11% of patients who underwent LHM. Our study validates the hypothesis that the laparoscopic approach is superior to the thoracoscopic one in relieving dysphagia and preventing heartburn and regurgitation. Good to excellent results were observed in 95.2% of patients who underwent LHM, compared with 62.5% of patients treated with THM. The higher incidence of persistent or recurrent dysphagia observed in the THM group should be correlated to the inadequate extension of the myotomy distally onto the stomach. We agree with other authors<sup>5,9,10,14,15,18</sup> in recognizing that the crucial and decisive part of the procedure is to carry the myotomy 2 to 3 centimeters distally.

Furthermore, with the laparoscopic approach, an antireflux procedure can be added to decrease the incidence of gastroesophageal reflux. Pellegrini et al<sup>2</sup> reported an incidence of abnormal esophageal acid exposure of 13% after THM without an antireflux procedure. Patti et al<sup>9</sup> in an extensive study of 168 patients with achalasia reported postoperative gastroesophageal reflux in 6 of 10 patients tested (60%) after THM and in only 17% of those tested after LHM with Dor fundoplication.

The results of the present experience show that the occurrence of reflux symptoms is significantly higher in the group treated thoracoscopically. In these patients, we found an increase in esophageal acid exposure with a significantly higher rate of heartburn (12.5%) and regurgitation (18.7%), presumably because of an insufficient and slow clearance of acid during reflux episodes.

Although several recent studies have suggested that an associated fundoplication is necessary to prevent gastroesophageal reflux after the myotomy,<sup>5,10,13,15</sup> the debate is still open. Yamamura et al<sup>18</sup> recently reviewed 21 cases of laparoscopic Heller myotomy with anterior fundoplication and observed significant improvement in dysphagia, heartburn, supine and upright regurgitation, and chest

pain in 95.2% of patients. Patti et al<sup>9</sup> suggest that an anterior fundoplication does not increase the risk of postoperative dysphagia or prevent gastroesophageal reflux. However, similar results have been published by other authors<sup>17,19</sup> in a series of patients treated with laparoscopic Heller myotomy without an antireflux procedure. Wang et al,<sup>17</sup> in a series of 25 patients, obtained postoperatively a 14% incidence of regurgitation and 11% of heartburn. Richards et al<sup>19</sup> reviewed the results of esophageal function tests in 14 of 16 patients treated with laparoscopic Heller myotomy without antireflux surgery and found a gastroesophageal reflux rate of 21%. The patient with the highest DeMeester score had a postoperative LES pressure higher than 20 mm Hg, indicating that the clearance of acid reflux was significantly impaired. This study demonstrated that the incidence of gastroesophageal reflux can be low even without a fundoplication in the presence of a postoperative LES pressure  $\leq 10$  mm Hg, with a poor correlation between LES pressure and the degree of acid reflux by 24-h pH monitoring. In some cases, anterior fundoplication may lead to rehealing and reapproximation of the myotomy with secondary development of stricture and recurrent achalasia, as argue the opponents of this procedure.<sup>16</sup>

In our study, 3 patients who underwent LHM with reconstruction of the angle of His had an abnormal esophageal acid exposure with symptoms of heartburn in only 1 patient. This patient was treated successfully with acid suppressant medications. It is important to emphasize that some patients are asymptomatic refluxers. In fact, the absence of reflux symptoms is not necessarily connected with objective abnormal acid reflux episodes encompassed at the pH monitoring as a decrease of esophageal pH below 4. The 2 subgroups of LHM patients treated, respectively, with or without fundoplication are too small to draw any conclusion to the real efficacy of the anterior fundoplication in the prevention of GER. In addition, the results of pH monitoring are still not complete and we are waiting to finalize our evaluation.

In spite of the fact that an anterior fundoplication can be followed by the potential problem of "rehealing" of the myotomy, the results obtained in our experience have led us to prefer this procedure to other fundoplications. The operation should be performed with limited dissection of the esophagus, as we believe that preserving the support of the posterior structures around the gastroesophageal junction is essential to maintain the mecha-

nism of a competent cardia. In fact, the potential problem of rehealing of the myotomy has led us to treat 7 of our patients with long-standing achalasia who have developed an esophagus with a diameter >6 cm, with myotomy followed by reconstruction of the angle of His. We have not seen any difference in clinical outcomes between these patients and those who underwent Dor fundoplication.

In conclusion, we agree with those authors<sup>4,9</sup> who support the laparoscopic Heller-Dor procedure. This procedure is highly effective in abolishing dysphagia and in preventing postoperative reflux and heartburn. We believe that the dispute between thoracoscopic and laparoscopic approaches for Heller myotomy should be definitively ended, despite the absence of prospective randomized studies.

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